

## CARPOGONIA AND CARPOSPOROPHYTES OF MONTAGNE'S TAXA OF *BATRACHOSPERMUM* (RHODOPHYTA) FROM FRENCH GUIANA

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**ABSTRACT** - Based on the type specimens of French Guiana, carpogonia and carposporophytes of Montagne's taxa of the genus *Batrachospermum* were examined to determine their taxonomic status. *Batrachospermum torridum*, *B. guyanense* (Montagne) comb. nov., *B. nodiflorum* and *B. ambiguum* must be assigned to the section *Contorta*. In contrast, *B. equisetifolium* and *B. macrosporum* (syn. *B. oxycladum* and *B. excelsum*) are placed in the section *Aristatae*, to which *B. cayennense* is assigned.

**RÉSUMÉ** - L'auteur a examiné les carpogones et carposporophytes des spécimens-type des *Batrachospermum* de la Guyane française décrits par Montagne (1850) afin de déterminer leurs positions taxonomiques. *B. torridum*, *B. guyanense* (Montagne) comb. nov., *B. nodiflorum* et *B. ambiguum* sont assignés à la section *Contorta*; *B. equisetifolium* et *B. macrosporum* (syn. *B. oxycladum* et *B. excelsum*) à la section *Aristatae* à laquelle appartient *B. cayennense*.

**MOTS CLÉS** : *Batrachospermum*, French Guiana, Montagne's taxa, type specimen.

### INTRODUCTION

Based on the specimens collected by Leprieur from French Guiana, Montagne (1850) published "Cryptogamia Guyanensis", in which he reported 76 taxa including 9 taxa of the genus *Batrachospermum*. At this time, no reproductive characteristics of Rhodophyta such as spermatangia and carpogonia were found. Montagne did describe the carposporophyte as clusters of sporangia (sporangium glomerulo), although he gave no text figures.

Sirodot (1884) referred Montagne's taxa, namely, *Batrachospermum torridum* Montagne (as *B. vagum* var. *torridum* (Montagne) Sirodot), *B. vagum* var. *guyanense* Montagne, *B. nodiflorum* Montagne (as *B. vagum* var. *nodiflorum* (Montagne) Sirodot), *B. ambiguum* Montagne, *B. equisetiflorum* Montagne, *B. cayennense* Montagne, *B. macrosporum* Montagne, *B. excelsum* Montagne (as *B. macrosporum* var. *excelsum* (Montagne) Sirodot) and *B.*

*oxycladum* Montagne (as *B. macrosporum* var. *oxycladum* (Montagne) Sirodot).

Although *B. macrosporum* Montagne has been referred by Skuja (1933) without text figure, Thérézien (1985) and Kumano & Necchi (1990) showed text figures of carpogonia and carposporophytes of this species based on French Guiana and Brazilian collections. Bourrelly (1970) showed spermatangia, carpogonia and carposporophytes of *B. cayennense* Montagne based on the type specimen of this species and Kumano & Ratnasabapathy (1982) based on Malaysian collection.

The present study presents the other specimens of Montagne with detailed analyses of their carpogonia and carposporophytes to determine their taxonomic positions.

### SPECIMENS EXAMINED

The following nine specimens of Leprieur collection, which were deposited in the Herbarium of Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris, were examined:

- 1) *Batrachospermum torridum* Montagne, Coll. n° 833, on rocks in quiet rivulets near Tigres mountains in Cayenne Island;
- 2) *Batrachospermum vagum* var. *guyanense* Montagne, Coll. n° 1108, in running freshwater near Cayenne,
- 3) *Batrachospermum nodiferum* Montagne, Coll. n° 1107, on rocks in quiet rivulets near Tigres mountain in Cayenne Island;
- 4) *Batrachospermum ambiguaum* Montagne, Coll. n° 1110, in Rivulet Orapu;
- 5) *Batrachospermum cayennense* Montagne, Coll. n° 348, in running water in mountain around Cayenne;
- 6) *Batrachospermum equisetifolium* Montagne, Coll. n° 1109, on rocks in Creek Gravier in Kew mountains;
- 7) *Batrachospermum macrosporum* Montagne, Coll. n° 1105, on submerged wood at the bottom of Rivulet Orapu and Comte;
- 8) *Batrachospermum oxycladum* Montagne, Coll. n° 1106, on stems of drift wood in rivulet, in upstream of Rivulet Comte, 120km from Cayenne;
- 9) *Batrachospermum excelsum* Montagne, Coll. n° 1104, on stems of submerged plants in Rivulet Oyac.

### DESCRIPTION

#### 1. *Batrachospermum torridum* Montagne (Figs. 1-5)

*Batrachospermum torridum* Montagne 1850, p. 292. Syn. *B. vagum* var. *torridum* (Montagne) Sirodot 1884, p. 266.



Figs. 1-5: *Batrachospermum torridum* Montagne. - 1-2: a slightly-curved carpogonium-bearing branch and carpogonium with club-shaped trichogyne. 3: carposporangia subterminal on gonimoblast filaments with terminal hairs. 4: carposporangia terminal on gonimoblast filaments. 5: monosporangia lateral on primary branchlets. (cp, carposporangium; cf, cortical filament; gf, gonimoblast filament; m, monosporangium; pb, primary branchlet; r, rosetto-like lateral; s, spermatangium; sb, secondary branchlet; tr, trichogyne).

No spermatangia were observed. Carpogonium-bearing branch arising from the pericentral cell, consisting of 6-9 (N=5) disc- or barrel-shaped cells, slightly curved; carpogonium about 4 $\mu$ m (N=5) wide at the base, 9-12 $\mu$ m (N=5) wide at the apex, 35-40 $\mu$ m (N=5) long; trichogyne club-shaped, bent at the base, and more or less indistinctly stalked (Figs. 1, 2). Bracts short. Carposporophytes are globose or semiglobose (Figs. 3, 4), 170-350 $\mu$ m (N=6) high, 300-450 $\mu$ m (N=6) in diameter, gonimoblast filaments long, consisting of 5-10 cylindrical or barrel-shaped cells, radially branched and more or less loosely agglomerated, sometimes terminated with long hair cells. Carposporangia obpyriform or ellipsoidal, 7-10 $\mu$ m (N=23) wide, 10-13 $\mu$ m (N=23) long, terminal on laterals of gonimoblast filaments (Figs. 3, 4). Monosporangia ellipsoidal, 6-9 $\mu$ m (N=11) wide, 7-11 $\mu$ m (N=11) long, laterals of primary branchlets (Fig. 5).

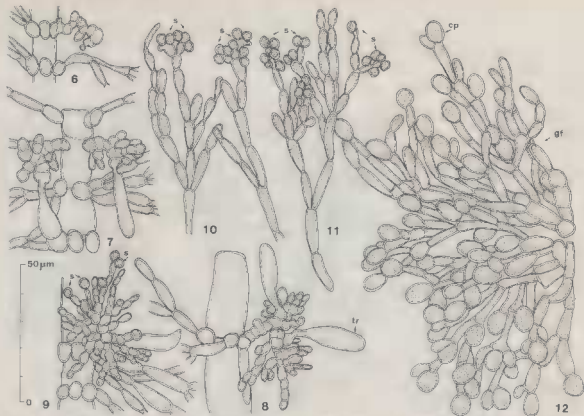
**Notes:** Montagne (1850) described that "spora pedicellatae, limbatae seu nucleum granulosum in perisporio includentes, sphaericae, diametro 0.01 millim. vix metientes". Based on the type specimen (Coll. n° 833) of this species, the figures of the carposporophytes and carposporangia were drawn by Montagne with pencil, but, not accompanied by figures of carpogonia and spermatangia. This species resembles *B. tortuosum* Kumano (1978) and *B. doboense* Kumano et Bowden-Kerby (1986), for the latter of which carposporangia and carposporophytes were unknown, in having the slightly curved carpogonium-bearing branches, but differs from *B. tortuosum* and *B. doboense* in having monosporangia. As the result of the occurrence of the slightly curved carpogonium-bearing branch, this species may be assigned to the section *Contorta* (Skuja, 1931) with *B. tortuosum* and *B. doboense*, although it may be regarded as an intermediate form between the sections *Contorta* and *Viridia*.

## 2. *Batrachospermum vagum* var. *guyanense* Montagne (Fig. 6-12).

*Batrachospermum guyanense* (Montagne), comb. nov. Basionym *B. vagum* var. *guyanense* Montagne 1850, p. 266.

Spermatangia globose, 4-6 $\mu$ m (N=40) in diameter, on terminal or subterminal clusters of the primary and secondary branchlets (Figs. 10, 11), and also on laterals around carpogonium bearing branches (Fig. 9). Carpogonium-bearing branch arising from the pericentral cell, consisting of 6-11 (N=8) disc- or barrel-shaped cells, spiral or twisted; carpogonium about 7 $\mu$ m (N=8) wide at the base, 9-12 $\mu$ m (N=8) wide at the apex, 35-45 $\mu$ m (N=8) long; trichogyne club-shaped, more or less indistinctly stalked (Figs. 6-8). Bracts numerous. Carposporophytes are globose and inserted centrally (Fig. 12), 150-220 $\mu$ m (N=10) in diameter; gonimoblast filaments long, consisting of 5-8 cylindrical cells, radially branched and loosely agglomerated. Carposporangia globose or ellipsoidal, 9-12 $\mu$ m (N=40) wide, 10-15 $\mu$ m (N=40) long, terminal on laterals of gonimoblast filaments (Fig. 12).

**Notes:** Based on the specimen (Coll.n° 1108) the figures of spermatangia were drawn by Montagne with pencil, but not with figures of carposporophytes and carpogonia. This species resembles *B. kushiroense*



Figs. 6-12: *Batrachospermum guyanense* (Montagne), comb. nov. - 6: carpogonium-bearing branch in early stage of development. 7-8: carpogonium-bearing branches with bracts (laterals). 9: spermatangia terminal on the laterals around carpogonium-bearing branch. 10-11: spermatangia terminal on the primary branchlets. 12: carposporangia terminal on gonimoblast filaments.

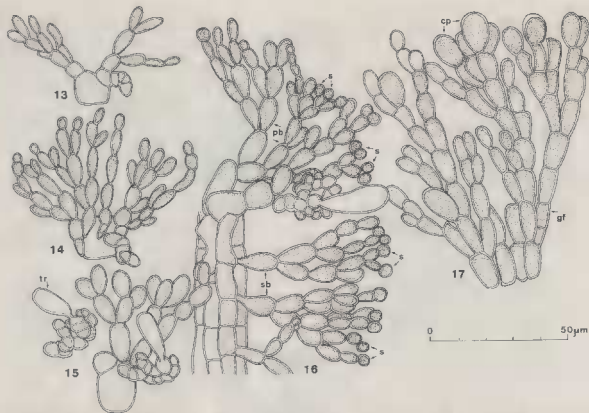


Fig. 13-17: *Batrachospermum nodiflorum* Montagne. - 13-14: carpogonium-bearing branch in early stage of development. 15: spirally twisted carpogonium bearing-branch and carpogonium with ellipsoidal trichogyne. 16: carpogonium-bearing branch and spermatangia terminal on the primary and secondary branchlets. 17: carposporangia terminal on gonimoblast filaments.

Kumano et Ohsaki (1983) in having the curved carpogonium-bearing branches and the loosely agglomerated gonimoblast filaments, but differs from the latter in the size of carpogonium. As the result of the occurrence of the curved carpogonium-bearing branch, this species is not a variety of *B. vagum* of the section *Turficola*, but assigned to the section *Contorta*. Thus, a new combination is proposed as *B. guyanense* (Montagne) comb. nov., basionym *B. vagum* var. *guyanense* Montagne.

### 3. *Batrachospermum nodiflorum* Montagne (Figs. 13-17).

*Batrachospermum nodiflorum* Montagne 1850, p. 294. Syn. *B. vagum* var. *nodiflorum* (Montagne) Sirodot 1884, p. 266.

Spermatangia globose, 5-8  $\mu\text{m}$  (N=22) in diameter, terminal on the primary and secondary branchlets (Fig. 16). Carpogonium-bearing branch arising from the pericentral cell, consisting of 3-9 (N=7) disc- or barrel-shaped cells, twisted; carpogonium 7-9  $\mu\text{m}$  (N=7) wide at the base, 9-13  $\mu\text{m}$  (N=7) wide at the apex, 30-50  $\mu\text{m}$  (N=7) long; trichogyne ellipsoidal or club-shaped, more or less indistinctly stalked (Figs. 13-16). Bracts very short. Carposporophytes are semiglobose or wart-like, 200-400  $\mu\text{m}$  (N=6) high, 350-550  $\mu\text{m}$  (N=6) wide; gonimoblast filaments long, consisting of 5-10 barrel-shaped cells, radially branched and compactly agglomerated. Carposporangia obovoidal or ellipsoidal, 10-13  $\mu\text{m}$  (N=18) wide, 15-20  $\mu\text{m}$  (N=18) long, terminal on laterals of gonimoblast filaments (Fig. 17).

**Notes:** Montagne (1850) described that "spores initio perisporio inclusae, tandem liberae ovoideo-oblongae, 0.02 millim. longae, angustiores, granulosa, virides." Based on the type specimen (Coll. n° 1107) of this species, the figures of the carposporophytes and carposporangia were drawn by Montagne with pencil, but not with figures of carpogonium and spermatangia. This species resembles *B. Hirosei* Ratnasabapathy et Kumano (1982) in having the wart-like carposporophytes, but differs from the latter in the size of spermatangia, carpogonia, carposporophytes and carposporangia. As the result of the occurrence of the spirally twisted carpogonium-bearing branch, this species must be assigned to the section *Contorta*.

### 4. *Batrachospermum ambiguum* Montagne (Figs. 18-23).

*Batrachospermum ambiguum* Montagne 1850, p. 296

No spermatangia were observed. Carpogonium-bearing branch arising from the pericentral cell (Figs. 18, 19, 21) and cortical cell (Fig. 20) consisting of 4-8 (N=8) disc or barrel-shaped cells, spiral or twisted; carpogonium 4-8  $\mu\text{m}$  (N=8) wide at the base, 9-10  $\mu\text{m}$  (N=8) wide at the apex, 15-26  $\mu\text{m}$  long; trichogyne ellipsoidal, more or less indistinctly stalked (Figs. 18-21). Bracts very short. Carposporophytes are globose and inserted centrally, 100-170  $\mu\text{m}$  (N=8) in diameter, gonimoblast filaments long, consisting of 5-10 cylindrical or barrel-shaped cells, radially branched and agglomerated. Carposporangia globose or ellipsoidal, 7-8  $\mu\text{m}$  (N=25) wide, 9-11  $\mu\text{m}$  (N=25) long, terminal on laterals of gonimoblast filaments (Fig. 23).

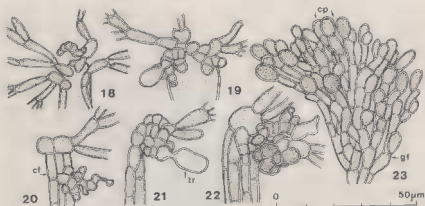


Fig. 18-23: *Batrachospermum ambiguum* Montagne. - 18, 19, 21: spirally coiled carpogonium-bearing branch with carpogonium with ellipsoidal trichogyne. 20: a carpogonium-bearing branch arising from cortical cell. 22: initials of gonimoblast filaments. 23: carposporangia terminal on gonimoblast filaments.

**Notes:** Montagne (1850) described that "sporarium glomerulis frondi sessilibus crassis numerosis". Based on the type specimen (Coll. n° 1110) of this species, the figures of carposporophytes and carposporangia were drawn by Montagne with pencil, but not with figures of carpogonia and spermatangia. Because of the spirally twisted carpogonium-bearing branch, this species also must be assigned to the section *Contorta*.

##### 5. *Batrachospermum cayennense* Montagne

*Batrachospermum cayennense* Montagne 1850, p. 291

Spermatangia globose, 6-7 $\mu$ m (N=10) in diameter, terminal on the primary and secondary branchlets. Carpogonium-bearing branch arising from the pericentral cell, consisting of 12-17 (N=7) disc- or barrel-shaped cells; carpogonium 6-8 $\mu$ m (N=7) wide at the base, 9-13 $\mu$ m (N=7) wide at the apex, 29-38 $\mu$ m (N=7) long; trichogyne ellipsoidal or spatular-shaped, more or less indistinctly stalked. Carposporangia obovoidal or ellipsoidal, 10-13 $\mu$ m (N=12) wide, 20-30 $\mu$ m (N=12) long, terminal on laterals of gonimoblast filaments.

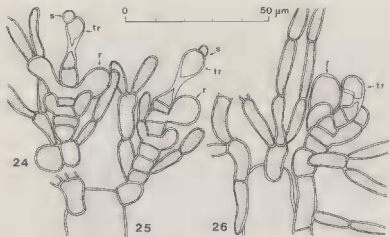
**Notes:** This type specimen (Coll. n° 348) was re-examined by Bourrelly (1970). This species is assigned to the section *Aristatae* (Skuja, 1931).

##### 6. *Batrachospermum equisetifolium* Montagne (Figs. 24-26).

*Batrachospermum equisetifolium* Montagne 1850, p. 295.

No spermatangia were observed. Carpogonium-bearing branch arising from the pericentral cell, consisting of 4-7 (N=5) disc- or barrel-shaped cells; carpogonium 7-10 $\mu$ m (N=5) wide at the base, 9-11 $\mu$ m (N=5) wide at





Figs. 24-26: *Batrachospermum equisetifolium* Montagne. - 24-26: carposporophyte-bearing branch with rosette-like laterals and carposporophyte with spatular-shaped trichogyne.

the apex, 25-35 $\mu$ m (N=5) long; trichogyne ellipsoidal or club-shaped, more or less indistinctly stalked. A hypogynous cell produces rosette-like laterals. No carposporophytes and carposporangia were observed.

**Notes:** Montagne (1850) reported no sporangia. Based on the type specimen (Coll. n° 1109) of this species, no figures of carposporophytes and carposporangia were drawn by Montagne. *B. equisetifolium* differs from *B. macrosporum* in the size of the trichogyne. The carposporophyte is 25-35 $\mu$ m long in *B. equisetifolium*, while the carposporophyte is about 35-45 $\mu$ m long in *B. macrosporum*. These two species, however, resemble each other in having hypogynous cells forming rosette-like laterals. At present, *B. equisetifolium* is assigned to the section *Aristatae*, to which *B. cayennense* is assigned. However, it will be proposed that this species is placed in a new section together with *B. hypogynum* and *B. macrosporum* (Kumano & Necchi, 1990) rather than the section *Aristatae* in the near future.

### 7. *Batrachospermum macrosporum* Montagne

*Batrachospermum macrosporum* Montagne 1850, p. 293.

No spermatangia were observed. Carposporophyte-bearing branch arising from the pericentral cell, consisting of 4-9 (N=13) disc- or barrel shaped cells; carposporophyte 9-15 $\mu$ m (N=13) wide at the base, 14-18 $\mu$ m (N=13) wide at the apex, 35-45 $\mu$ m (N=13) long; trichogyne ellipsoidal or spatular-shaped, more or less distinctly stalked. Carposporangia obovoidal or obpyriform, 25-30 $\mu$ m (N=30) wide, 30-55 $\mu$ m (N=30) long, terminal on laterals of gonimoblast filaments (Fig. 17).

**Notes:** Montagne (1850) described sporangia. Based on this type specimen of this species, the figures of carposporophytes and carposporangia were drawn by Montagne with pencil, but not with figures of carpogonia and spermatangia. This type specimen (Coll. n° 1105) has been re-examined by Skuja (on the specimen dated 8/6 1957), Bourrelly (1970), Thérézien (1985). As Kumano & Necchi (1990) mentioned, it will be proposed that this species is assigned to a new section together with *B. hypogynum* rather than the section *Aristatae* in the near future.

#### 8. *Batrachospermum oxycladum* Montagne

*Batrachospermum macrosporum* Montagne 1850, p. 293. Syn. *B. oxycladum* Montagne 1850, p. 293, *B. macrosporum* var. *oxycladum* (Montagne) Sirodot 1884, p. 269.

No spermatangia were observed. Carpogonium-bearing branch arising from the pericentral cell, consisting of 6-9 (N=10) disc- or barrel-shaped cells; carpogonium 9-15µm (N=10) wide at the base, 15-20µm (N=10) wide at the apex, 35-45µm (N=10) long; trichogyne ellipsoidal or spatular-shaped, more or less distinctly stalked. No carposporophyte and carposporangia were observed.

**Notes:** Montagne (1850) reported no sporangia. Based on the type specimen of this species, no figures of carposporophytes and carposporangia were drawn by Montagne. As Skuja (on the specimen dated 13/6 1957) and Thérézien (1985) mentioned, this specimen (Coll. n° 1106) must be a juvenile female specimen of *B. macrosporum*.

#### 9. *Batrachospermum excelsum* Montagne

*Batrachospermum macrosporum* Montagne 1850, p. 293. Syn. *B. excelsum* Montagne 1850, p. 291, *B. macrosporum* var. *excelsum* (Montagne) Sirodot 1884, p. 268.

Spermatangia globose, 5-8µm in diameter, terminal on the primary and secondary branchlets. No other reproductive organs were observed.

**Notes:** Montagne (1850) reported no sporangia. Based on the type specimen of this species, no figures of carposporophytes and carposporangia were drawn by Montagne. As Skuja (on the specimen dated 8/6 1957) and Thérézien (1985) mentioned, this specimen (Coll. n° 1104) must be a male specimen of *B. macrosporum*.

### CONCLUSION

Based on examinations of carpogonia and carposporophytes, taxonomic status of each specimen are considered as follows:

1) *Batrachospermum torridum* Montagne 1851, p. 292, syn. *B. vagum* var. *torridum* (Montagne) Sirodot 1884, p. 266. This species may be assigned to the section *Contorta*.

2) *Batrachospermum guyanense* (Montagne), comb. nov., a new combination is proposed for this taxon, as *B. guyanense* (Montagne) comb. nov., basionym *B. vagum* var. *guyanense* Montagne 1850, p. 266. This species must be assigned to the section *Contorta*.

3) *Batrachospermum nodiflorum* Montagne 1850, p. 294, syn. *B. vagum* var. *nodiflorum* (Montagne) Sirodot 1884, p. 266. This species must be assigned to the section *Contorta*.

4) *Batrachospermum ambiguum* Montagne 1850, p. 296. This species also must be assigned to the section *Contorta*.

5) *Batrachospermum cayennense* Montagne 1850, p. 291. This species is assigned to the section *Aristatae*.

6) *Batrachospermum equisetifolium* Montagne 1850, p. 295. At present, this species is placed in the section *Aristatae*.

7) *Batrachospermum macrosporum* Montagne 1850, p. 293, syn. *B. oxycladum* Montagne 1850, p. 293, *B. macrosporum* var. *oxycladum* (Montagne) Sirodot 1884, p. 269, *B. excelsum* Montagne 1850, p. 291, *B. macrosporum* var. *excelsum* (Montagne) Sirodot 1884, p. 268). At present, this species is assigned to the section *Aristatae*.

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